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The Oil Potential of the Barents Sea: A Future Soviet Bonanza

A Research Paper

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July 1986

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A Research Paper

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The Oil Potential of the Barents Sea: A Future Soviet Bonanza

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Summary

Information available as of 30 May 1986 was used in this report.

The Barents Sea has the potential for being a major oil bonanza for the USSR. We estimate that recoverable oil resources in the Soviet portion of the Barents could amount to about 30 billion barrels—about the same amount as that of the North Sea. If proved and developed, these resources would be adequate to support average production rates of 2 million barrels per day (b/d)—about one-sixth of current Soviet output—for more than 40 years, or 3 million b/d for more than 25 years. No other new oil region in the Soviet Union appears to hold such promise. If Barents Sea oil helps keep Soviet exports to hard currency countries up, and, therefore, imports from the West, the United States could confront a somewhat healthier Soviet economy a decade or so from now than many Western experts currently envision.

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Oil production in the Barents could technically begin by 1990 and reach 500,000 b/d or more by the mid-1990s. Actual production levels will depend on the priority the Soviets give to the development of Barents Sea oil and their access to Western technology designed specifically for Arctic conditions.

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Although a harsh area, the Barents Sea presents no environmental problems that would make development of oil impossible. Because of the influence of the Gulf Stream, conditions in the southern part of the Barents are similar to those in the North Sea, an area that has been in production for many years. Conditions in the north are similar to those in the Canadian Beaufort Sea, which is presently being explored by Western firms and will be developed when economic conditions permit.

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No breakthroughs in technology will be required to develop the Barents Sea oil. Many types of offshore platforms presently in operation in the North Sea are well suited for operations in ice-free regions of the southern part of the Barents. This technology is available from various West European manufacturers, most of whom would probably be eager to enter the potentially lucrative Soviet offshore market. Given the depressed oil market outlook for the next few years, the Soviets can expect attractive offers from Western manufacturers. The technology needed to exploit the environmentally tougher northern part of the Barents exists in the West and could be provided by Finnish, British, Norwegian, Canadian, or US firms. We believe, however, that any effort to develop the northern Barents is still another 10 to 15 years down the road, at the earliest.

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Development of the Barents Sea oil will have an important impact on the Soviet energy balance in the latter half of the 1990s. Major production from the Barents could begin at a time when output from the primary onshore regions, especially West Siberia, is expected to be in sharp and irreversible decline. A Barents breakthrough would help the Soviets avoid the enormous expense of moving extensively to inefficient enhanced oil recovery techniques in onshore oilfields, shifting their fuel use even more rapidly away from oil, or adjusting their foreign trade to improve domestic oil supplies. Any of these options would probably be more expensive and far more difficult than the admittedly large investment needed to exploit Barents oil resources.

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Exploitation of the Barents could be a boon to Western petroleum equipment and service companies. If Moscow turns to the West for Arctic-offshore technology, the Barents would represent one of the largest markets during the next decade. The United States, however, would not be in a strong position to capture much of this business. Although the United States is a world leader in most aspects of offshore technology—and the Soviets have privately admitted a preference for US technology—we believe that the Soviets will try to keep direct equipment purchases from the United States to a minimum.

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The cost per barrel of developing Barents Sea oil will exceed that of all regions of the non-Communist countries currently in production. To limit investment costs, Moscow could use the Barents Sea to experiment with joint ventures between the Soviets and Western firms, American or otherwise. Although the Soviets would approach such arrangements with great caution, their need for access to Western petroleum technology for Arctic development might incline them to such arrangements. Although the Barents' strategic importance to Moscow as a naval staging, transit, and exercise area will work against this option, the Soviets could use offers to help develop the Barents Sea as leverage to gain political concessions. At a minimum, the Barents may present Moscow with an opportunity to create friction between the United States and its allies in the event the United States were to oppose Western participation in Barents Sea development. No matter what strategy is finally adopted, the possibility that the Barents Sea oil could help Moscow keep oil exports to the West at high levels, coupled with prospective deliveries of Soviet natural gas, suggests that the USSR over the long term may figure more heavily in Western Europe's energy picture than we now foresee.

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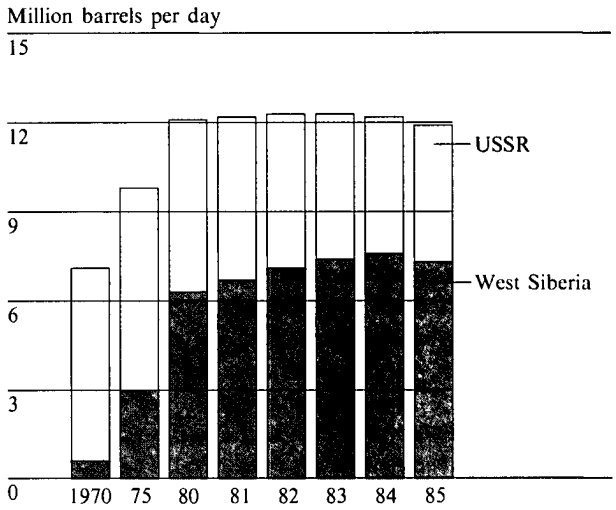
The Soviet Challenge: Increase Oil Reserves

After 42 years of uninterrupted growth, Soviet oil production peaked at 12.3 million barrels per day (b/d) in 1983 and slipped to about 11.9 million b/d by 1985. In addition to continuing declines in other regions of the USSR, production in Western Siberia—which accounts for about 60 percent of national oil output—dropped for the first time by about 300,000 b/d in 1985 (figure 1). According to various Soviet press and technical reports, mounting problems with equipment failures and downtimes, progressively poorer quality reserves, shortages of skilled labor, and inadequate levels of investment were the major factors responsible for the production shortfall. Although it is still too soon to predict future production trends with much certainty, our best estimate is that Soviet oil production will continue to decline gradually during the rest of the 1980s, possibly falling to about 11.0 million b/d by 1990.

In the past, the Soviets have been able to maintain growth in oil production by finding and developing large new oil provinces—Urals-Volga in the 1950s and West Siberia in the late 1960s and 1970s. Soviet leaders, however, have publicly stated that new discoveries in West Siberia will be smaller, more difficult to find, and far more costly to develop. Faced with this situation, the Soviets plan to step up exploration work in both offshore and onshore regions to ensure a reserve base to support the oil production needed in the 1990s and beyond. One of the announced priority objectives of the current Five-Year Plan (1986-90) is to develop the oil potential of the nation's continental shelf.[1] We interpret this to mean that the Soviets will step up exploration in the Barents Sea—the world's largest continental shelf.

[1] A continental shelf is a shallow submarine plain of varying width forming a border to a continent and typically ending in a steep slope to the oceanic abyss.

Figure 1
Soviet Oil Production, Selected Years



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On the basis of our detailed investigation of the oil potential of the Barents Sea, we believe this region could be one of the world's most productive continental shelves (see appendix).[2] Although any estimate of the oil potential in a virgin area like the Barents Sea is subject to considerable uncertainty, we believe that:

- There is only a small chance that the potential of the Soviet portion of the Barents Sea will not be at least as big as Alaska's Prudhoe Bay (recoverable reserves of about 10 billion barrels).
- There is an excellent chance that the Barents potential will be in the North Sea range (around 25-30 billion barrels).

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[2] This study refers only to oil; natural gas and gas condensate are not included.

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The Soviet-Norwegian Boundary Dispute

The Soviet and Norwegian boundary claims in the Barents Sea overlap, creating a disputed area of some 159,000 square kilometers—an area slightly larger than the Middle Atlantic states of Virginia, Maryland, Delaware, and New Jersey combined.

In 10 years of periodic negotiations, the Soviet Union and Norway have made little progress toward resolving their maritime dispute (see figure 5).

Our geological analysis indicates that the disputed area of the Barents Sea contains all or part of at least eight large structures—ranging in size from 800 to 5,000 square kilometers—that are potentially petroleum bearing. The disputed area is referred to geologically as the Central Barents Uplift and the Perseus Uplift. We estimate that about 8 billion barrels of potentially recoverable oil exists in this area. If proved-up, this amount of oil could approximate that of Alaska's Prudhoe Bay. The Norwegians are well aware of this area's oil potential. The Soviets have conducted some drilling at a point estimated by Norway to be inside the disputed territory, suggesting that they too understand an oil stake may be involved in the ongoing dispute. We doubt that the oil involved in the disputed area figures heavily in Soviet energy plans, at least in the short-to-medium term. As noted, far larger amounts of oil probably exist in areas of the Barents that are clearly Soviet territorial waters.

- There is an outside chance that the Barents potential is in the Kuwait range (75-90 billion barrels).

Another 8 billion barrels may exist in regions of the Barents Sea subject to a boundary dispute between the USSR and Norway (figure 5).

Geographic and Geologic Setting of the Barents Sea

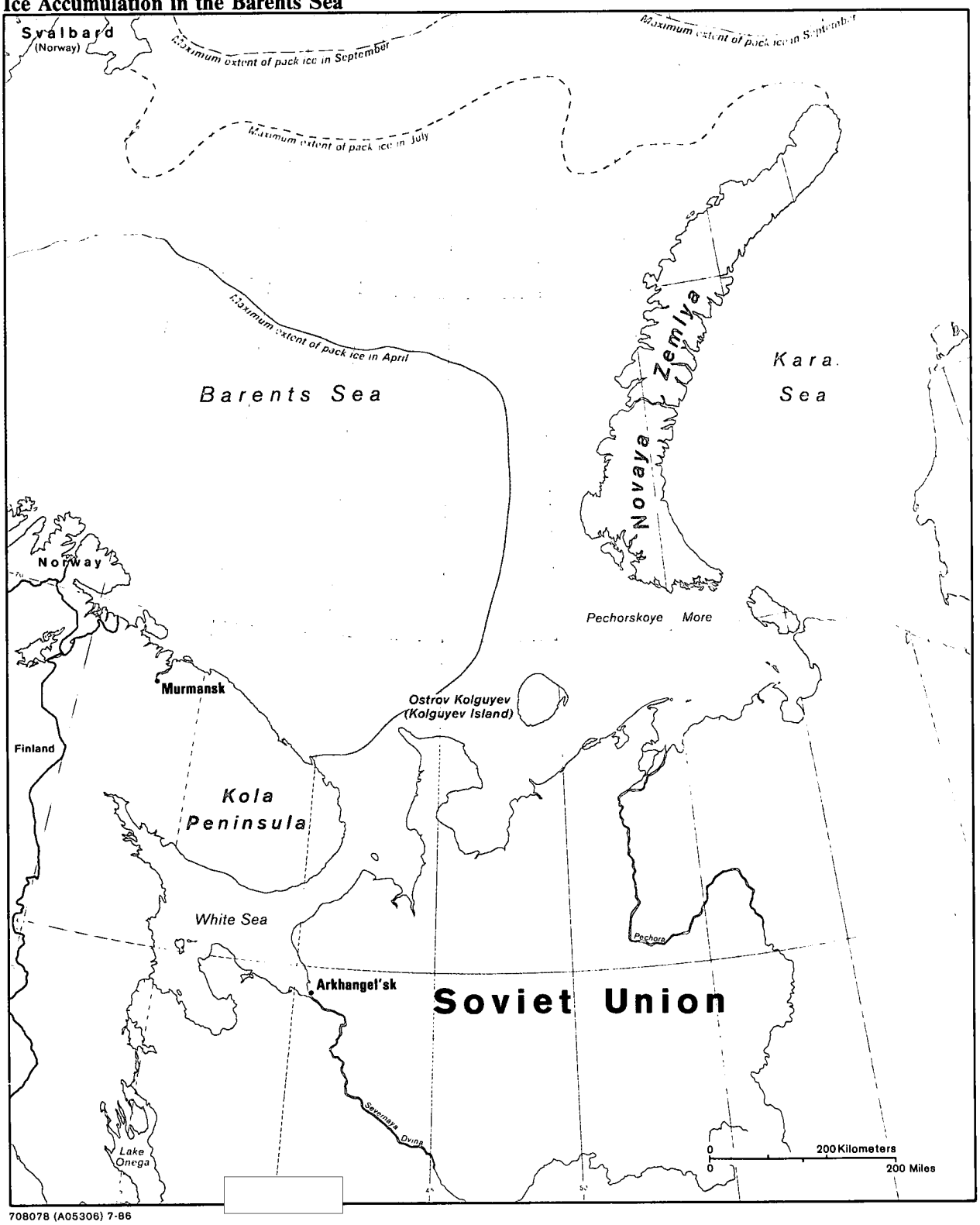
Geographic Factors: Not All Bad News. The geography of the Barents Sea presents some encouraging signs for potential oil development. Even though it lies entirely within the Arctic Circle and covers an area of 1.3 million square kilometers (km^2)—roughly half the size of the West Siberian Basin—the Barents is a shallow, navigable sea, a factor that encourages the search for its oil. The average water depth is 220 meters, a depth easily within present Western offshore drilling capabilities, although well out of range of Soviet offshore technology. According to industry reports, Western oil companies are already producing oil at water depths in the 200- to 300-meter range; in 1985 Brazil set a world record for seafloor completions at 385 meters. The Soviets, in contrast, have yet to produce oil at water depths greater than 75 meters.

The southern part of the Barents Sea environmentally and logistically is the most favorable area for petroleum development.[3] Because of the warm North Cape current (an extension of the Gulf Stream) that crosses this region from west to east, ice formation is virtually nonexistant most of the year except on some inland rivers and gulfs (figure 2). Relatively long periods of clear weather and moderate temperatures are more prevalent here than in any other part of the Barents. The Murmansk area with its extensive industrial and maritime support facilities is relatively close to potential drilling sites in the region.

Our analysis of oceanographic and meteorological data indicates that the strong wave action prevalent in the Barents is likely to be the most serious environmental constraint. This part of the Barents contains some of the most storm-ridden waters in the world; waves commonly rise between 3 and 4 meters in height. During periods of strong west winds (especially common during the fall and winter), the surge can be greater than 10 meters.

[3] For the purpose of this study, we have divided the Barents Sea into a southern and northern part using the 75th parallel as the boundary line.

Figure 2
Ice Accumulation in the Barents Sea



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The environmental conditions in the northern part of the Barents are even more severe. The region is iced over for many months of the year (September through May), with perennial pack ice forming in the far north and northeast. Icebergs often hinder movement, especially near Novaya Zemlya, Franz Josef Land, and Svalbard. Other navigational hazards include persistent snowstorms in winter and dense fog in summer.

The northern area is also much less accessible to logistic supply bases and routes to support petroleum exploration and development efforts. Major shipping lanes of the Northern Sea Route pass far to the south, the area is remote from the nearest major resupply points on the Kola Peninsula, and many of the most promising oil-bearing regions are located more than 1,000 kilometers from Murmansk, the major resupply point. To exploit the northern part of the Barents, the Soviets would have to substantially augment their offshore support capabilities or attempt to support their offshore drilling efforts from closer land-based supply sites; perhaps bases would have to be built on Novaya Zemyla or Franz Josef Land. In any event, development of the northern part of the Barents Sea would entail an engineering and logistic effort on a scale never before attempted by the USSR.

Geology Very Promising. Our analysis of Soviet and Western geological literature indicates that the Barents Sea contains the three major factors necessary for the generation and accumulation of oil—source rocks, traps, and seals. Source rocks are organically rich, black marine shales that will generate oil and gas when subjected to sufficiently high temperatures caused by burial at great depths for long periods of time. We believe that the most likely source rock in the Barents Sea is a highly bituminous shale very similar to the Kimmeridgian age shales of the North Sea and the Bazhenov shale of the huge West Siberian Basin, and both areas are established oil-producing regions. Our analysis of bathymetric (seafloor) maps and Soviet technical literature indicates the presence of many traps capable of holding accumulations of oil, some of which are large enough to represent potential supergiant oilfields.[4] We have the least information on the nature of the seals that are likely to be present in the Barents Sea; seals are necessary to hold oil accumulations in place. On the basis of direct evidence on some Soviet drilling activity conducted thus far and information on analogous regions in the Norwegian part of the Barents, however, we believe that the odds are very good that effective seals exist.

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The source rocks in the southern part of the Barents—from the Devonian to the Jurassic geological periods—typically are organically rich and very productive. Analysis of geological and bathymetric data indicates a considerable amount of faulting in areas near the shore, suggesting that most of the oil that is likely to be found in this geologically complex area will appear in small traps at considerable depth—probably more than 3,500 meters in most cases. The southeastern portion of the Barents Sea is an offshore continuation of the Pechora plate and probably a close geological analogue to the onshore Timan-Pechora Basin in the northwestern part of the USSR. The Soviets have been producing about 350,000 b/d in this basin for many years.

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We believe that five major geological provinces in the southern part of the Barents are good prospects for oil. These provinces geologically are referred to as the Murman-Timan High, the Goose Bank Margin, the Samoylev Trench, West Novaya Zemyla, and the Pechora Sea (figure 3). Analysis of bathymetric data indicates the presence of numerous potential petroleum-bearing structures trending in an east-west direction and ranging in size from 350 to 2,000 km².

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Our analysis indicates that structures in the northern part of the Barents Sea are geologically younger than those in the southern area. The rocks range from the Cretaceous through the Permian periods. The northern part of the Barents Sea has been stable for millions of years, further helping to create highly favorable conditions for the generation of large amounts of oil. Four large geological provinces exist in

[4] A supergiant field contains more than 5 billion barrels of oil.

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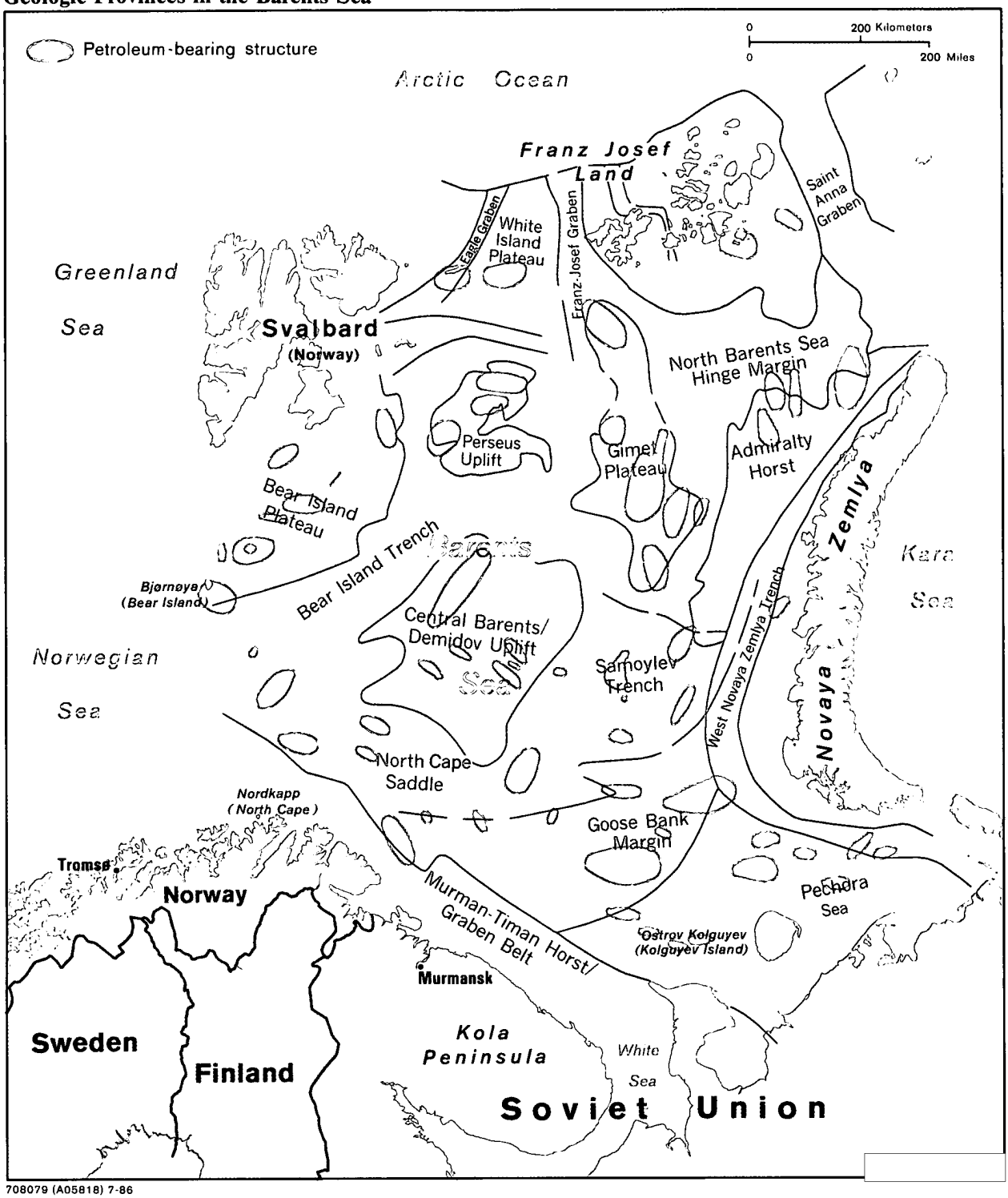
Figure 3
Geologic Provinces in the Barents Sea



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the northern part of the Barents—the Admiralty Horst, Franz Josef Land, the Gimet Plateau, and the North Barents Hinge Line. Within these areas, we have identified numerous petroleum-bearing structures, trending in a north-south direction and ranging in size from 2,000 to 5,000 km². [redacted] 25X1

Oil-in-Place and Potentially Recoverable Resources

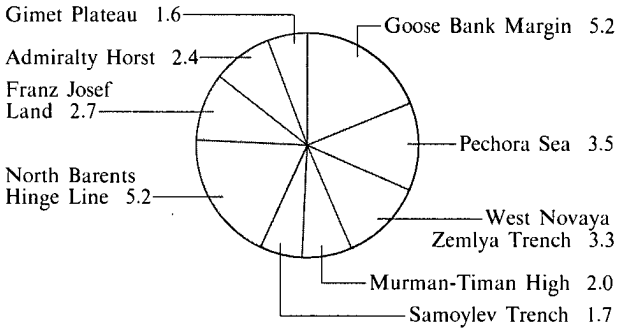
The key initial measure of the oil potential of a new region is the amount of oil-in-place. Oil-in-place is the total estimated amount of oil that may have migrated into a reservoir, most of which for economic or technical reasons can never be recovered. Extensive field exploration, drilling, and development are necessary to prove oil-in-place in commercial quantities. Therefore, the Barents, without proved reserves, is only a potential resource—that portion of the oil-in-place that can be inferred from geologic or other geophysical data but has not yet been confirmed by a full program of drilling. [redacted] 25X1

Nevertheless, on the basis of our analysis of the geological conditions likely to exist in the Barents Sea, [redacted] we estimate the oil-in-place in the Barents Sea at about 150 billion barrels. Because of the intentionally conservative estimating approach we have taken, higher amounts might actually be closer to the mark. As the Soviets move further along in their drilling and exploration program and more data on source rocks and reservoirs become available—a process likely to take another three to five years—this estimate will be refined. [redacted] 25X1 25X1 25X1

Converting oil-in-place into proved reserves will require a program of exploratory and delineation (measurement) drilling on a scale that the Soviets have never attempted before in an offshore area. On the basis of the experiences of other offshore oil producers, the Soviets can reasonably expect to recover from 20 to 40 percent of the oil-in-place. Much will depend on the type of reservoirs that are found to exist in the Barents and the efficiency of the Soviets in managing production operations. For estimating purposes, we are assuming that the Soviets will achieve an overall recovery of only 20 percent, much lower than average recoveries currently being posted by many offshore producers in the North Sea and the Bay of Campeche. At this recovery factor, potentially recoverable resources in the Barents Sea would amount to about 30 billion barrels. This puts the oil potential of the Soviet portion of the Barents Sea in the same league as the North Sea. [redacted] 25X1 25X1

We estimate that as much as 16 billion barrels of the potentially recoverable oil could lie in the southern area of the Barents Sea or, in some cases, could be in structures that straddle the 75th parallel (figure 4). This oil would be located in numerous individual basins of various sizes. We do not know what size field the Soviets consider the minimum for commercial development. In Western practice, a field would have to be in the 50- to 100-million-barrel range to justify development under conditions similar to those in the

Figure 4
Northern and Southern Barents Sea: Potentially Recoverable Oil



southern part of the Barents Sea. The odds are favorable that many basins of at least that size will be found in this area.

We estimate that the remaining 12 billion barrels of oil lie in the northern portion of the Barents Sea. In Western practice, a field would have to contain 350-500 million barrels to be considered viable, given the severe environmental conditions in this area. In view of the size of the structures that we believe are present in the northern Barents, the odds are favorable that fields of that size will be present in this area. Indeed, supergiant fields are possible in this region. The northern part of the Barents Sea is largely unexplored, however. No offshore exploration wells have been drilled and few, if any, seismic or aeromagnetic surveys have been conducted. Large oil potential notwithstanding, the long leadtimes—probably 10 to 15 years—needed to develop this region mean that there is virtually no chance that any production could come from this area until after the turn of the century.

Soviet Petroleum Exploration and Drilling Activity

Development of offshore oil resources is a time-consuming process even with the best conditions, such as shallow water, mild climates, and close-in logistic supply bases. The sequence in a typical offshore development cycle would normally entail:

- Five to seven years for exploration and delineation drilling.
- Five years or more to construct offshore platforms and conduct development drilling.

Normally, oil production can be expected about 10 years after the start of the exploration phase. Peak production for a particular field usually occurs three to four years later. For the most part, the Soviets are still in the early exploration phase in offshore areas of the southern part of the Barents Sea.

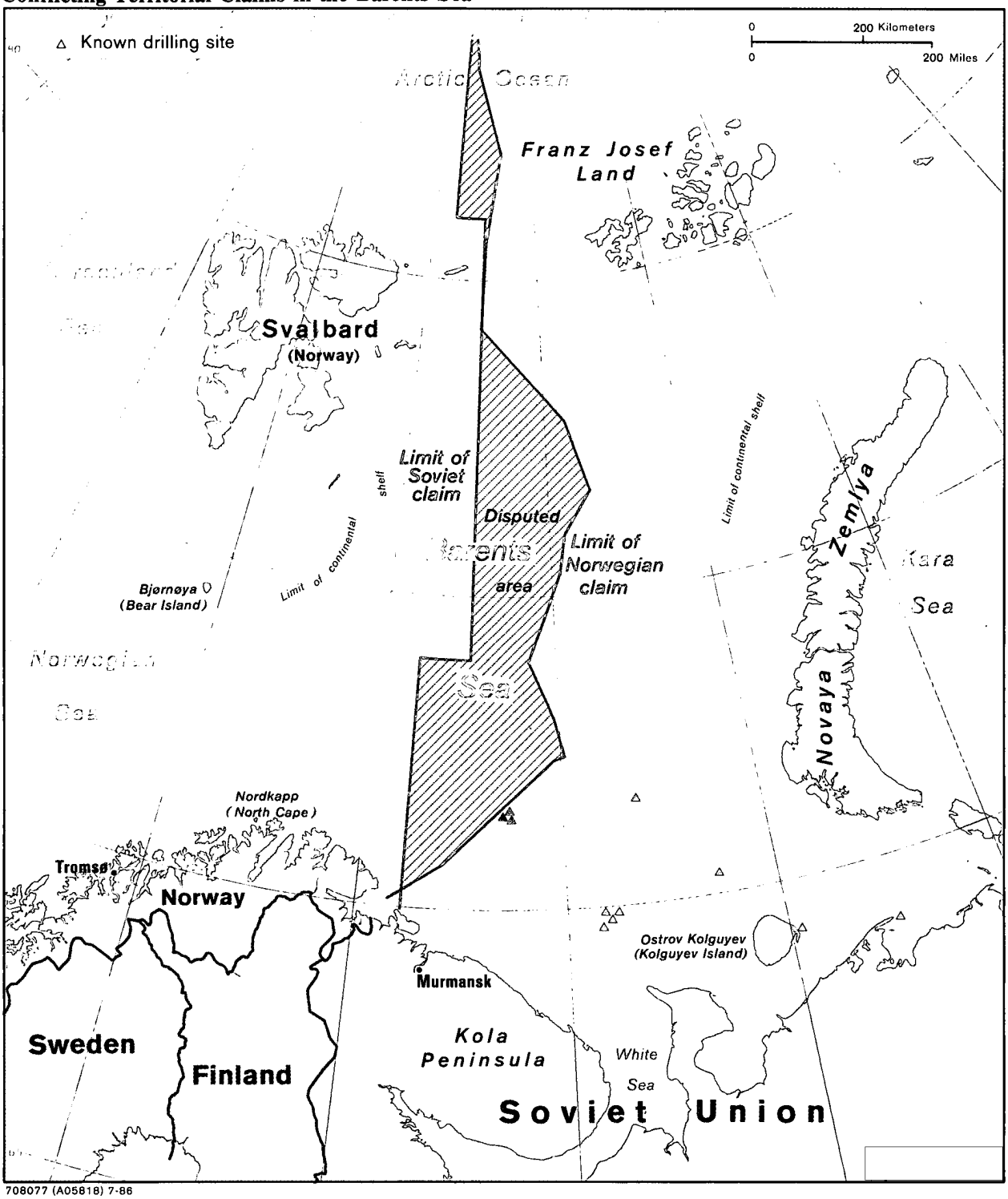
The Soviets have been actively collecting geological data in the Barents for more than two decades. They began exploring for oil in the Barents Sea in 1962. According to Soviet literature, seismic testing also began in that year close to the shore near the Timan-Pechora Basin. Multichannel seismic testing started in 1970 in the southern part of the Barents between the Kola Peninsula and Novaya Zemlya. The Soviet press reports that, in the last 15 years, the Soviets have conducted regional aeromagnetic, shipborne gravimetric, bottom sounding, and bottom sampling studies in the southern and western parts of the Barents Sea—including areas close to the territory in dispute between the USSR and Norway. 25X1 25X1

Exploration drilling began offshore in 1982, and, thus far, nine wells have been drilled in the southern part of the Barents (figure 5). Four gas discoveries have been reported in the Goose Bank Margin, ranging in depth from 3,000 to 3,500 meters. Three of the wells are near the Soviet-Norwegian boundary. Our analysis indicates that areas where drilling has occurred are basically gas prone. This does not mean that oil is not present, but it is more likely that gas will account for the major percentage of the hydrocarbon accumulation in a given area. We have no hard information to indicate that the Soviets have discovered any oil offshore in the Barents Sea to date. 25X1 25X1

One advantage the Soviets have in the southern part of the Barents is the existence of several landmasses, especially Kolguyev Island, that could help compress the exploitation timetable and save exploration and development costs if oil is found onshore. In fact, the Soviets reported an oil discovery in 1983 on Kolguyev Island, and the well tested at about 1,000 b/d before being shut in. we believe that the Soviets are now engaged in delineation drilling in that area. If the discovery proves large enough to produce and requires only onshore development technology, output could begin within five years. 25X1 25X1

The amount of drilling conducted thus far is very small, considering the size of the area involved and the depths at which oil is likely to be found. If our geological analysis of the southern part of the Barents Sea is accurate, the Soviets will need to drill several thousand meters deeper than they have thus far to find the oil we believe is likely to be there. As noted, most of the oil in the southern part of the Barents will probably exist at depths greater than 3,500 meters. Technically, the Soviets are fully capable of drilling to these depths. Although the Soviets have drilled only 25X1

Figure 5
Conflicting Territorial Claims in the Barents Sea



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Oil Drilling on Kolguyev Island

In early 1983 the Soviets announced the discovery of oil on the east coast of Kolguyev Island. Results of flow tests from the Peschanoozero oilfield, along with the areal extent of the drilling, indicate that the find is very large—possibly in the 500-million-barrel category. Limited crude oil production from this field could begin as soon as 1990, assuming that the Soviets can complete work for tanker loading.

We believe the Soviets will probably undertake offshore drilling as part of their effort to delineate the limits of Peschanoozero oilfield, though there was no evidence of offshore drilling by October 1985. On the basis of our analysis of selected West Siberian oilfields, we believe delineation drilling is just over half completed in the present area, and we expect it to be continued until at least 1989, given the current completion rate of eight wells per year. The Soviets most likely will expand the area being delineated through offshore drilling as well as onshore drilling to the north and west of the present area.

Kolguyev Island is in the geological province known as the Pechora Sea. We estimate that the Pechora Sea is one of the largest oil provinces in the Barents, with potential reserves of more than 3 billion barrels. The extensive exploration conducted in this region along with the delineation drilling now under way suggest that the Soviets also recognize this area's large oil potential.

one well in the Barents to 3,500 meters, we believe that they recognize the need to go deeper and drill more extensively and plan to step up exploration activity in the Barents Sea during 1986-90. Besides one semisubmersible rig built by the Soviets and two other Finnish-built drillships now operating offshore in the Barents, the Soviets recently imported a jack-up rig from Finland and plan to build their own large Arctic jack-ups with Finnish assistance by 1987 or 1988.

Soviet drilling activity conducted thus far and plans to increase the number of drill rigs in operation in the Barents over the next few years follow a logical pattern. The Soviets seem to be concentrating exploration in the Goose Bank Margin—an area we believe is of great potential—and on Kolguyev Island, the easiest area to work from logistically.

Outlook for Barents Development

The potential existence of a large oil resource base in the Barents Sea does not guarantee that the Soviets will make a massive effort to develop this region. Exploration efforts to date have been limited but seem to suggest that the Soviets are aware of the area's huge potential. To develop the region, Moscow must be willing and able to commit a large investment of money and skilled labor to support greatly expanded activities at a time when both are in short supply. The Soviets frankly admit that shortages of skilled labor—especially drilling and maintenance personnel—are already hampering production in West Siberian fields. We have no indication that this situation will improve much through the end of this decade.[5]

We believe that Moscow, faced with escalating investment requirements throughout the oil sector, will have comparatively few funds available over the next few years that can be earmarked for the Barents Sea. The Soviets have some breathing room with their Barents development, however, because they will be, for the most part, in the exploration phase for the next few years at least. During this period, comparatively modest outlays will be required, mainly involving the purchase of imported drilling rigs. The big investments in production systems will come in the 1990s.

How fast the Soviets proceed with exploration and development of the Barents Sea ultimately depends, in our judgment, on future trends in oil production in established regions of the USSR. If the production situation in established regions worsens faster than we now project, the Soviets will need to increase the priority given to new areas like the Barents Sea. On the other hand, if the Soviets manage to keep reserves up and to stabilize production—or at least keep the decline within limits they can live with—the need for developing new oil sources will lessen. Luck will also play a major role. Although unlikely, we cannot rule out the possibility that the Soviets will yet find large amounts of new oil onshore. Some areas of Western Siberia located north of the prolific Middle Ob' Basin have never been explored by drilling and are good prospects for additional oil discoveries. Although the operating conditions in Western Siberia are perhaps the worst the Soviets now face, the Soviets at least have vast experience working in such harsh onshore environments and could move farther north with some confidence. Clearly, development of a given amount of new oil in Western Siberia, if discovered, would require much less investment than an equal amount in the Barents Sea.

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Cautious Approach Likely. We believe that Moscow will proceed with the exploration and ultimate development of the Barents Sea but at a very cautious pace. The Soviets traditionally take a go-slow approach to projects for which they lack experience. Between now and 1990, we expect an increase in Soviet exploration activity, concentrated exclusively in the environmentally less demanding southern part of the Barents Sea. According to our geological assessments, exploration would focus on the Pechora Sea Province and Goose Bank Margin which, in our view, are the largest oil-prone areas in the southern part of the Barents.

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At best, production of Barents oil in significant quantity is five to eight years away. Given the experiences of offshore oil producers in the West, the odds are favorable that initial large oil discoveries will be made sometime between four to six years after extensive exploratory drilling has begun. While this rule of thumb is no guarantee of success, it at least suggests that the Soviets, with drilling experience dating back to 1982, are entering the window when the possibilities for oil discoveries in the Barents are most favorable. We believe that initial production could begin about five years after confirmation of a discovery, with peak production being reached, in a particular field, two to three years later if Soviet experiences in the Barents follow offshore patterns in somewhat comparable regions like the North Sea. If these estimates prove correct, some commercial production could begin in the southern Barents by the mid-1990s. Much will depend, of course, on the priority the Soviets give to the Barents, the scale of investments, and the possible extent of participation by Western oil companies.

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Soviet Equipment Needs for Development of the Barents Sea

Soviet offshore oil capabilities are more limited than those of Western nations; most of the equipment and technology employed in Soviet offshore exploration and development has been either purchased from the West or reproduced from technology supplied by Western firms. Soviet offshore development experience to date has primarily been limited to the more benign conditions of the Caspian Sea in water depths of less than 35 meters. [redacted]

The Soviets recognize their offshore limitations and are emphasizing to many countries the potential market offered by the Barents Sea. The Soviet shopping list for Barents Sea development is headed by requests for detailed engineering studies applicable to the particular reservoir and environmental conditions existing in the Barents Sea. In general, the type of ice conditions, if any, and the size of the oilfield involved will dictate the most suitable type of production platform. The selection process for the best production facility, however, is extremely complex. Many types of offshore production technologies already exist that would be suitable in ice-free parts of the southern Barents. Western industry has also developed more than 50 different conceptual designs for ice-resistant production platforms. In addition to the United States, West European nations, including the United Kingdom, Italy, France, and Norway, could provide this type of engineering and management service. In our view, costs for the initial conceptual work would be as much as $5 million. [redacted]

If oil is found in the ice-free areas of the Barents Sea, Norwegian companies, such as the Aker group or Norwegian contractors—specialists in offshore concrete platforms—could get the contract. If oil is found in the eastern Barents Sea where ice is more of a factor, Finnish companies with Arctic ice experience, such as Rauma Repola or Valmet, could win large contracts. Additionally, numerous service companies from West European countries, such as the United Kingdom, Sweden, Netherlands, Italy, France, and Norway, would be needed to provide specialized services, such as platform installation using heavy-lift barges, module hookup, drilling, diving, and pipeline services and supply operations. Norwegian companies would be strong candidates to help the Soviets build support bases, and locations, such as Murmansk or Kirkenes (Norway), have already been discussed as possibilities, according to various trade journals. [redacted] 25X1

Except for sophisticated computer hardware and software, very little equipment used in offshore field development is controlled by COCOM export regulations. Most of the dual-use, COCOM-controlled items involve equipment used in offshore exploration, such as seismic survey vessels, satellite navigation equipment, and acoustic/ultrasonic underwater exploration equipment. The most likely type of controlled equipment desired by the Soviets for oilfield development projects is submersible vehicle systems, such as remotely operated vehicles (ROVs), that are used to install, inspect, and repair subsea installations. The Soviets are reported [redacted] *to be actively seeking advanced ROV equipment and technology. Less advanced ROVs are available from a number of foreign suppliers.* [redacted]

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Production Possibilities Large. At this stage, discussion about oil production in the Barents is very speculative. It is possible, however, to use analogs based on Western oil industry experience to illustrate the ranges of output that are consistent with the amounts of oil we think are involved and the present state of production technology:

- Our engineers believe that initial production from land-based operations on Kolguyev Island is possible by 1990. We do not have information on the size of the discovery in this area, but, in view of the extent of the delineation drilling (375 km^2), a possible field size of 500 million barrels is reasonable. If this estimate is fairly accurate, average production of about 100,000 b/d could be sustained for at least a decade from this area alone.

- If the Soviets prove-up sizable amounts of offshore oil in the southern part of the Barents between now and 1990, commercial production is possible by the mid-to-late 1990s. From an engineering perspective, additional production as high as 500,000 b/d around 1995 is reasonable and could be supported by perhaps five steel-tower drilling platforms, comparable to average size platforms operating in the North Sea.

- At the upper end of the range, if the Soviets intend to operate in the Barents Sea for 25 years—a fairly common planning period in the West—our estimate of the resource base for the entire Barents would theoretically be adequate to support average production of about 3 million b/d. This is about the current level of output in the North Sea and roughly half the production of West Siberia.

More Adventuresome Options. Exploration of the oil resources of the Barents Sea could be accelerated by joint arrangements with Western firms. Such arrangements would, of course, require the Soviets to make substantial ideological concessions, but there are precedents for such flexibility if the gain is judged to be great enough. Lenin's advocacy during the 1920s of using Western firms to develop Soviet resources might serve as ideological justification.

The Barents Sea offers attractive possibilities for some type of joint arrangement in the unlikely event the Gorbachev regime were to try a bold initiative. The Barents Sea is an isolated area and could be exploited by Western firms with little visibility and, from Moscow's point of view, little contamination of Soviet society. Given the capital-intensive nature of Western petroleum operations, the number of Western workers would be small. 25X1

A long-shot possibility is that the Soviets might make the Barents an "export zone" and earmark all of the area's output to hard currency markets. Such a move would give the Soviets the option of dedicating all of their onshore production to meet domestic needs and the requirements of their client states. In this way, Barents development would not directly affect the domestic economy or Soviet military potential. 25X1

Strategic military sensitivities would be the major stumblingblock to any arrangement involving Western participation. The Barents provides the only access to the Atlantic Ocean for the Soviet Northern Fleet based on the coast of the Kola Peninsula; and it is the site of year-round naval activity that includes exercises, sea trials, and missile testing. The Soviet military surely would oppose any proposal to give foreign oil workers access to the Barents Sea, no matter how few were involved. At a minimum, strategic considerations would appear to virtually rule out the possibility of any direct US participation. 25X1

Some Decision Points and Indicators. If Barents Sea oil is to play a role in the Soviet energy picture after 1995, major offshore discoveries will have to be proved-up within the next three to five years. We believe that there is a better-than-even chance that major discoveries will be made during this time frame. For the next few years at least, we expect to see a gradual buildup in Soviet exploration with more drillships operating in the Goose Bank Margin and the Pechora Sea. We may also see a step-up in the pace of negotiations with Western offshore equipment producers during the same time frame. Offshore platforms, for example, would have to be ordered sometime between 1988 and 1990 to be in operation by 1995. 25X1 25X1

In contrast to the usual Soviet practice of giving broad, public media coverage to promising industrial or resource developments, the Soviets have been tight-lipped regarding activities in the Barents Sea. To our knowledge, the Soviets have made no mention of the possibility of a major oil discovery on Kolguyev Island, for example. Soviet reticence in this case may stem from the strategic sensitivity of the Barents itself or because of the heat Soviet geologists have recently been taking from senior government officials for exaggerating the oil resource potential in some areas of West Siberia. In the case of the Barents, the Soviets may keep public reporting to a minimum until they are confident that all the results are in.

Implications

For the USSR. A large new source of oil in the Barents Sea presents Soviet planners with a variety of attractive domestic and foreign policy options. If Moscow is confident that nationwide oil production can be maintained at acceptable levels, the Soviets may opt to slow exploration efforts in harsh onshore areas, cut back plans to develop high-cost East Siberian coal, reduce efforts to expand nuclear power production, or refrain from moving to high-cost enhanced recovery techniques in old oilfields. Output from the Barents Sea would also make it easier for the Soviets to remain a major oil exporter. Oil sales to the West are the USSR's most important source of hard currency earnings and have brought billions into Soviet coffers. Many Western experts believe that Soviet oil exports to hard currency countries will be squeezed in the 1990s because of expected declines in domestic production, forcing the USSR to reduce badly needed imports of Western equipment and technology. Imports of Western offshore technology will be very expensive and present Soviet planners with some tough choices in assigning priorities to competing import requirements. If Barents Sea oil eventually helps keep Soviet foreign earnings up and, therefore, imports from the West, the United States might confront a somewhat healthier, more robust Soviet economy a decade or so from now than many Western experts currently believe will be the case.

For the West. Development of the oil resources of the Barents Sea would present major trade opportunities for the West, especially Finnish and Norwegian offshore equipment manufacturers. Offshore oil platforms similar to those operating in the North Sea are suitable to support production operations in many areas of the Barents. This type of platform can easily cost $250 million. Arctic-grade rigs capable of operating in moderate-to-severe ice conditions can cost as much as $400 million. During the 1990s, Soviet purchases of platforms alone could involve several billion dollars at a minimum. Direct purchases of exploration equipment, repair and logistic facilities, and services could easily run into the billions of dollars as well. 25X1

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Moreover, output from the Barents Sea theoretically represents an additional source of oil for Western Europe in the 1990s and beyond. Soviet oil presently accounts for slightly more than 10 percent of West European oil imports. This share conceivably could grow in the 1990s, especially if the Barents resources are developed primarily for export purposes. Such an outcome, coupled with prospective deliveries of Soviet natural gas, suggests that the Soviets could figure even more heavily in Western Europe's energy picture in the 1990s than we now envision. 25X1

For the United States. Development of the Barents Sea presents some trade opportunities for the United States, but probably small ones at best. Many Western countries can supply the USSR with the type and quantity of equipment and technology that will be required. And given the depressed oil market that most likely will exist for the next few years, many Western suppliers would be eager to get a piece of the potentially lucrative Soviet offshore market. If the Soviets begin to purchase some big-ticket items in the next few years, financially attractive offers are likely to come from a variety of suppliers. 25X1

Although the Soviets in their media have repeatedly labeled the United States an unreliable trading partner, Soviet officials have privately admitted that they trust US petroleum engineering expertise and technology. Although the Soviets will probably try to keep direct equipment purchases from the United States to a minimum, we believe they may seek US engineering 25X1

and management assistance in devising possible development strategies, and, perhaps, in identifying appropriate equipment and technology. At most, however, this type of assistance would probably fall into only the $10-20 million range and be spread over several years.

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Although US companies are not likely to get much of the business associated with Barents development, the United States could use Barents activities to push for new joint commercial arrangements between the Soviets and Western firms. Moscow clearly needs access to Western technology, especially if development of the Barents is seen as the best way to maintain oil production in the mid-to-late 1990s. Given this priority and the flexibility of a regime interested in exploring new economic arrangements, the United States could encourage its allies to push for joint ventures for Barents development. If successful, such ventures would give the West greater access to certain regions of the Soviet Union and some influence on certain dimensions of its economic development. The obvious strategic naval importance of the Barents, however, will work against this option and would certainly preclude US firms from direct operation in the region.

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The development of the Barents Sea offers Moscow possible political opportunities, in addition to obvious economic benefits. With the Barents Sea likely to be the only major offshore oil development that will be undertaken anywhere for the next decade, Moscow could dangle the possibility of multibillion dollar deals in front of Western governments in the hope of extracting political concessions. Indeed, it would not be surprising to see a replay of the frictions that occurred a few years ago over construction of the Soviet gas pipeline to Western Europe.

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Appendix

Oil Potential of the Barents Sea: Our Methodology

Estimation of the Soviet oil potential in the Barents Sea involves consideration of three factors:

- The amount of oil generated through geochemical processes in source rocks.
- The proportion of the generated oil effectively trapped in reservoir rocks.
- The portion of the trapped oil that is actually recoverable.

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Our approach concentrated on the source rock potential of the area. Source rocks are usually organic-rich, black marine shales or limestones that will generate oil when subjected to sufficiently high temperatures caused by burial at great depth for a long period of time. Generation of oil or gas depends on the length of time that a source rock is subjected to a given temperature. Source rocks subjected to low temperatures for a short period of time will not produce oil from organic matter; source rocks subjected to high temperatures for too long a period of time will have their oil and gas forced out through decomposition and expansion.

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A middle range of temperatures and times exists, however, where oil and gas are generated and preserved (figure A-1). Oil is generated only at the low end of this temperature range. Source rocks in this time-temperature range are in the "oil window." At the high-temperature end of the range, the generated oil breaks down into gas. Source rocks in this time-temperature range are in the "gas window." As oil or gas is generated, it is ejected from the source rocks and caught in traps or reservoirs. The petroleum potential of an area can be estimated by calculating how much oil is generated, and subsequently trapped, and how much of the trapped oil can ultimately be produced.

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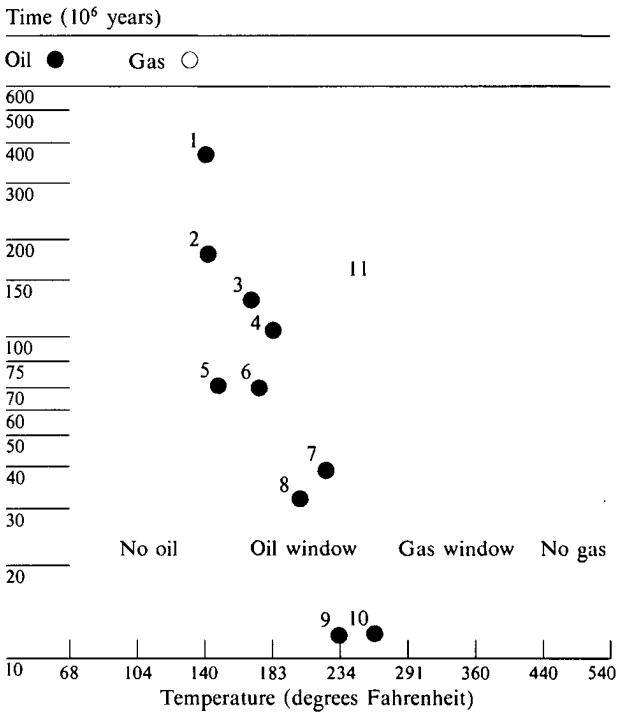
The estimating approach used in this study—which begins with a geochemical technique called the time-temperature index (TTI)—is, in our view, the best for cases, like the Barents Sea, where data limitations

Figure A-1
Location of Oil and Gas Windows According to Time and Temperature Framework



1 Amazon Basin, Brazil
2 Paris Basin, France
3 Aquitaine Basin, France
4 El Aaiun Area, Rio de Oro, West Africa
5 Douala Basin, Cameroon
6 Offshore Taranaki Basin, New Zealand
7 Camargue Basin, France
8 Offshore Taranaki Basin, New Zealand
9 Los Angeles Basin, California
10 Ventura Basin, California
11 Aquitaine Basin, France

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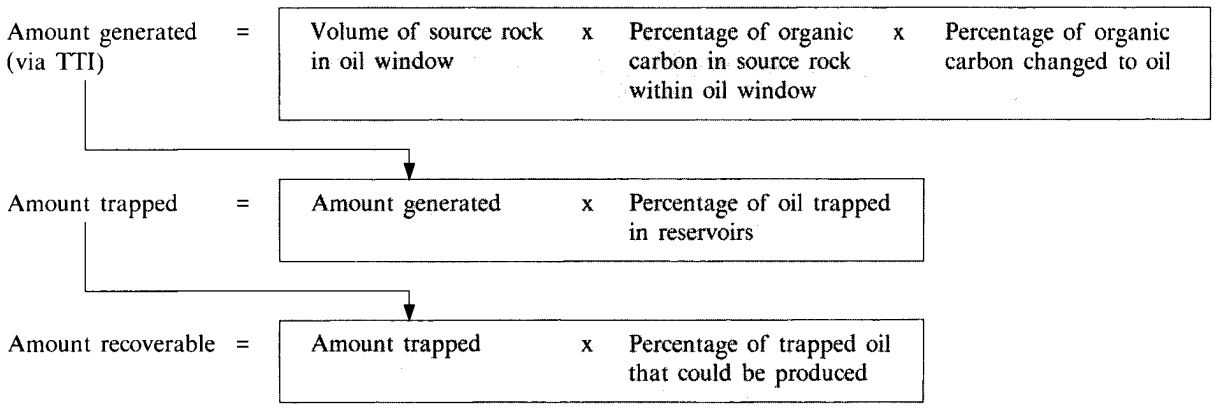
Figure A-2
Methodology for Estimating Barents Sea Oil Potential



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impose serious constraints (figure A-2). The methodology starts with an estimate of the volume of source rock and scales this figure for various geochemical and geological processes to arrive at an estimate of producible oil. Although the procedure accounts, in principle, for all of the factors influencing the ultimate amount of producible oil, much uncertainty is inherent in the values assigned to those factors in the calculation. Clearly, only a rough understanding exists of the detailed geological and chemical process that actually led to the presence of oil in the Barents Sea, so the procedure and its results should be interpreted with caution.

We have chosen a wide range of factor values to establish reasonable bounds on our estimates for the Barents. We have developed only a single estimate of source rock, however, because we feel the other factors are sources of even greater uncertainty. We chose a range of values that experts agree are reasonable for each factor, considering the conditions in the Barents region, as well as values considered to represent conditions that are most likely to exist there. Although the range of possibilities is wide, it is not unusual in a virgin area. Experience in many Western oil-producing regions has yielded similarly wide ranges at early stages of exploration comparable to that of the Barents. Although Soviet specialists clearly have a better, more comprehensive data base to work with, we are convinced that they face the same degree of uncertainty at this stage of exploration regarding the possible amounts of oil that will ultimately be found.

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The Calculations

In principle, we estimated the petroleum potential of the Barents Sea by a three-step calculation. We first estimated the amount of oil generated in the source rocks of the Barents Sea, then the amount of generated oil trapped in reservoirs, and finally, the amount of trapped oil that could be produced.

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To estimate the oil generated, we estimated:

- The volume of source rocks in the oil window—that is the volumes of source rocks that were heated to the proper temperature for the proper period of time to generate oil.
- The amount of organic carbon contained in the portions of source rocks that are within the oil window.
- The percentage of organic carbon found within the oil window that is changed into oil.

The amount of oil trapped is estimated directly by applying a "trapping" factor to the oil generated and the estimate of producible oil is obtained by applying a "producibility" factor to the amount of oil trapped.

Step 1: Amount of oil generated in Barents Sea source rock = (volume of source rock in oil window) × (amount of organic carbon in source rock in the oil window) × (percentage of organic carbon changed to oil).

Volume of Source Rock in the Oil Window

To obtain the volume of oil-generating source rock in the Barents Sea, we calculated the areal extent and thickness of the portions of the source beds that lie within the oil window. The thickness of source rock was obtained from Soviet drill records and from reconstruction of the depositional environment through geologic history. Environmental reconstruction was used to determine when, during the geologic past, the area of the Barents Sea was beneath a shallow sea—the ideal environment for the formation of source rock—with the thickness of the source rock being proportional to the period of submergence.

We calculated the temperature to which areas of source rock were heated over geologic time, using measurements of the amount of heat flowing from the center of the Earth. This heat flow was adjusted for variations in the basement rock beneath the Barents Sea. We eliminated from consideration as an oil source any areas that were underheated or overheated because they were clearly outside of the oil window. The areal extent of source rock in the oil window was multiplied by the thickness of the source rock within each area to obtain the total volume of source rock in the oil window in the Barents Sea. 25X1

Amount of Source Rock Organic Carbon in the Oil Window

The amount of oil that a source rock in the oil window generates ultimately depends on the organic carbon content of the source rock. Since no direct measurement of this factor was possible in source rocks in the Barents Sea, we used environmental reconstruction to estimate the organic carbon content. This approach is based on the fact that various subenvironments exist within a shallow sea. Varying amounts of organic carbon are deposited and preserved in each subenvironment. By determining which subenvironment a source rock was formed in, we could assign it an organic carbon content by analogy to similar source rocks for which organic carbon content has been measured. 25X1

Percentage of Organic Carbon Changed to Oil

Not all of the source rock organic carbon found within the oil window is changed into oil. The amount changed into oil depends on the type of organic material in the rock—especially whether it is of terrestrial or of marine origin. Because direct measurement of the specific type of organic matter present in the source rock was not possible, we again used environmental reconstruction to determine what type of organic matter was likely to be present. Such an approach is necessary because different types of organic matter are deposited in each subenvironment of a shallow sea.

Step 2: The amount of generated oil trapped in reservoirs = (the amount of oil generated in Barents Sea source rock from step 1) × (percentage of generated oil trapped in reservoirs).

Percentage of Generated Oil That Accumulates in Reservoirs

The percentage of oil and gas that accumulates in reservoirs depends on the physical characteristics of the source rock, the migration route, and possible

Oil Potential of the Barents Sea by Geological Province: Most Likely Case [a]

	Volume of Source Rock (*thousand km³*)	× Carbon content (*percent*)	× Carbon Conversion Factor	× Unit [b] Conversion Factor	= Volume of Generated Oil (*billion barrels*)	× Accumulation Coefficient (*percent*)	× Recovery Factor	= Potentially Recoverable Resources (*billion barrels*) [c]
Total								**27.6**
Geological province								
Southern Barents								15.7
Pechora	63	1.20	0.023	19.24	335	0.052	0.20	3.5
Goose Bank Margin	41	1.69	0.030	19.24	403	0.064	0.20	5.2
Samoylev Trench	12	1.58	0.029	19.24	105	0.050	0.20	1.7
Murman-Timan High	58	0.83	0.027	19.24	250	0.040	0.20	2.0
West Novaya Zemyla Trench [d]	38	0.92	0.030	19.24	201	0.082	0.20	3.3
Northern Barents								11.9
North Barents Hinge Line	43	1.82	0.030	19.24	457	0.057	0.20	5.2
Franz Josef Land	21	1.72	0.030	19.24	153	0.064	0.20	2.7
Admiralty Horst	26	1.29	0.029	19.24	187	0.064	0.20	2.4
Gimet Plateau	13	1.88	0.025	19.24	117	0.066	0.20	1.6

[a] We have not listed those geological provinces that we estimate have less than 1 billion barrels of potentially recoverable resources. These include Franz Victoria North, Franz Victoria South, White Island Plateau, and the North Cape Saddle. We estimate that the combined potential of these provinces amounts to about 1.4 billion barrels; about equally divided in the southern and northern parts of the Barents Sea.

[b] This factor converts source rock volume to rock weight by using an average rock density of 2.68 grams per cubic centimeter and converts oil weight back to volume by using an average oil gravity of 30 API.

[c] Because of rounding, components may not add to the totals shown.

[d] This province straddles the 75th parallel. To simplify the calculation, we have assigned it to the southern part of the Barents.

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reservoir rocks; the rate at which a source rock is buried; and the ease with which oil can travel out of the source rock and into the reservoir rock. We obtained information on the physical characteristics of the source and reservoir rocks from descriptions in the Soviet geological literature and from calculations based on our estimate of the presumed environments of deposition in the Barents Sea. We also derived estimates of the rate of source rock burial and the ease of oil migration from source to reservoir rock from reconstructions of the environment of deposition.

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Step 3: The amount of trapped oil that could be produced = (the amount of generated oil trapped in reservoirs from step 2) × (the percentage of trapped oil that could be produced).

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Percentage of Trapped Oil That Could Be Produced

The percentage of trapped oil that could be produced was obtained by taking industry estimates of oil recovery factors used in other environmentally harsh

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offshore areas (North Sea and North American Arctic) and applying them to the Barents Sea. In these environments, recovery factors ranging from 20 to 40 percent are being posted. Although recoveries in the Barents will ultimately vary considerably, an estimate of 20 percent is a cautious floor value, and recovery most likely will prove to be better. [redacted] 25X1

Estimates of Barents Oil Resources

Final estimates of Barents oil potential for our most likely assumptions are given in the table. They show that it is reasonable to expect about 30 billion barrels of recoverable oil. Similar calculations can be performed for more conservative and more liberal assumptions about conditions in the region. Taken together, these estimates indicate that:

- There is only a small chance that the potential of the Soviet regions of the Barents Sea will not be at least as big as Alaska's North Slope (recoverable reserves of about 10 billion barrels).
- There is an excellent chance that the Barents potential will be in the North Sea range (about 25-30 billion barrels).
- There is an outside chance that the Barents potential is in the Kuwait range (75-90 billion barrels).

[redacted] 25X1